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ALTITUDINAL MIGRATION OF BUTTERFLIES IN THE CENTRAL SIERRA NEVADA

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A SUBSTANTIAL PORTION of the butterfly fauna of the eastern United States participates in a general northward migration in late summer and early autumn, carrying many species up the Atlantic Coastal Plain far to the north of their permanent ranges (Clark and Clark, 1951; Nabokov, 1946; Shapiro, 1966). These species may overwinter successfully in mild years as far north as New York or New England but in severe winters may be exterminated as far south as Georgia. Apart from epigamic "hilltopping" phenomena, western and European collectors have known for many years that "strays" of lowland species frequently turn up at considerable elevations, and the literature is replete with such records, but the significance of this fact has been generally overlooked. Altitudinally inappropriate records have been a source of confusion to workers attempting to interpret western montane butterfly distributions in classical "life zone" fashion. Tilden (1959) lists a number of such species as "widely ranging" (and by implication breeding) across zonal boundaries. Two of these, the Buckeye (*Precis coenia* Hbn., Nymphalidae) and the Checkered White (*Pieris protodice* Bdv. and LeC., Pieridae) regularly move northward on the Atlantic Coastal Plain, often reaching eastern Massachusetts, but their inability to survive most northeastern winters casts some doubt on their adaptation to the similar winters of the mid- to high-elevation Sierra Nevada. Emmel and Emmel (1962) report both occurring commonly throughout the season at Donner Pass, ca. 7000 ft., Placer County. This Sierran locality is notorious for the severity of its winters. *P. coenia* is recorded up to lower Canadian Zone (8000 ft.) and *P. protodice* through Canadian (to 9000 ft.) in Yosemite by Garth and Tilden (1963). They consider *protodice* taken above 7000 feet to be strays.

In 1972, I collected intensively at sea level in the Sacramento Valley and at approximately 5000 and 7000 feet along Interstate 80 through the central Sierras in Nevada County, obtaining phenological and ecological data on butterflies and skippers. Certain inconsistencies with published Sierran data were immediately apparent; among these were the absences of *P. coenia* and *P. protodice* from apparently suitable habitats at both elevations in the mountains, and also of *Strymon melinus pudica* H. Edw., recorded by Garth and Tilden to 7000 feet and by Emmel and Emmel as common most of the season at Donner Pass in 1960. All of these species were eventually taken under circumstances suggesting strongly that their presence in 1972 was dependent on migration from lower elevations. All were abundant in the Sacramento Valley and foothills throughout the 1972 season.

Collecting was done in a great variety of habitats around Lake Spaulding, the Marin-Sierra Boy Scout Camp, and the intersection of I-80 with California Route 20, elevations near 5000 feet, and at Castle Peak-Boreal Ridge, along the Pacific Crest Trail, near 7000 feet. Both study areas supported very diverse montane butterfly faunas, producing 63 and 71 species, respectively. Collections were made weekly from 17 May to 27 October. In the course of these collections, two new altitudinal records were established for skippers (Hesperiidae) abundant in the Sacramento Valley, *Hylephila phyleus* Drury and *Lerodea eufala* Edw., and three specimens of the lowland species *Lycaena helloides* Bdv. (Lycaenidae) were taken. Tilden (1959) lists this species as one of the "widely ranging," non-zonal forms; Garth and Tilden (1963) record it through Transition Zone ("believed to be primarily a dweller of the lowlands, but occasional specimens have been found at higher elevations").

The 1972 records follow:

P. coenia: 5000′, 1 ♂ vii.28; 1 ♀ x.23. 7000′, 1 ♀ x.4.
L. helloides: 5000′, 1 ♂ vi.13; 1 ♀ vii.28. 7000′, 1 ♀ vii.17.
S. melinus pudica: 7000′, 1 ♂ ix.29.
P. protodice: 5000′, 1 ♀ x.4. 7000′, 2 ♂ 1 ♀ ix.7.
H. phyleus: 5000′, 1 ♀ ix.29.
L. eufala: 5000′, 1 ♂ viii.31.

Of these, the vii.28 *helloides* and x.4 *protodice* were extremely fresh and the vi.13 *helloides* and three ix.7 *protodice* and x.4 *coenia* very worn. The sexes and behavior of the insects militate against their presence being due to "hilltopping" (Shields, 1967).

From these records, it seems unlikely that any of these species overwintered at 5000 ft. or higher in 1971-72. The winter of 1971-72 was one of the driest of modern record in California (Dickson, 1972 a,b; Taubensee, 1972 a,b; Wagner, 1972). It is conceivable that poor snow pack (cf. U.S. Dept. of Commerce, 1972) failed to provide adequate insulation for overwintering individuals of sensitive species, a common occurrence in the northeastern U.S. (Shapiro, unpublished). However, it is not necessary to postulate successful overwintering to account for sizeable populations at high elevations, if migrants arrive early enough in the year from lower elevations and are able to breed successfully. This failed to occur in 1972. Emmel and Emmel recorded *P. coenia* common all the 1960 season at Donner Pass, beginning the second day of observation (vi.18), and *S. melinus* common from vii.7. (Emmel and Emmel's records of *P. protodice* are not altogether trustworthy as they do not record *P. occidentalis* Reakirt, a very similar species which is a common resident at both Donner Pass and Castle Peak.) (Some previous records of *L. helloides* in the Sierra may be based on misidentifications of *L. nivalis* Bdv., a montane species common at 7000 ft. and occasional at 5000.) In 1973, *P. coenia* and *S. melinus* did not reach Castle Peak, at the same elevation as Donner Pass, until so late in the year that morning frosts were general and cloudiness persistent. Similarly, in "bad" migration years in the northeast, *P. coenia* does not reach Philadelphia until early October, too late to reproduce successfully.

Hylephila phyleus is a regular migrant in the northeast, overwintering about one in every ten years at Philadelphia. In the Sierra its usual host plant, Bermuda grass (*Cynodon dactylon* (L.) Pers.), is absent but other possible hosts may be available. *Lerodea eufala* feeds in the Sacramento Valley on the grasses *Echinochloa crus-galli* (L.) Beauv. and *Setaria* and *Sorghum* spp. None of these occurs above the foothills, except perhaps in highly disturbed sites. *L. eufala*, formerly confined to southeastern California, has greatly extended its range northward in the past fifty years and may still be spreading northward and up-slope in and around the Central Valley; available records do not make clear whether it crossed the Tehachapi/Transverse Ranges or the Coast Ranges, but it obviously has considerable potential for dispersal.

Colias eurytheme Bdv. (Pieridae) is an ubiquitous species in California, from sea level to the Arctic-Alpine Zone. In the northeast, *C. eurytheme* has been permanently established on

the Piedmont and Coastal Plain north to Boston since the early 1930's, but it still overwinters only sporadically on the high plateaus of central New York and in the mountains of northeastern New York and New England. At Ithaca, New York, the very spotty overwintered butterflies are supplemented by a surge of worn, summer-phenotype immigrants in May or June every year. A similar phenomenon is to be expected in the Sierra. *C. eurytheme* is abundant in the Sacramento Valley from early March to late November or early December. At 5000 ft., a few *eurytheme* were flying as early as v.17, but at 7000 ft. none were seen before vi.30. At both elevations, the population peaked very conspicuously in late September and October. At 5000 ft. the first few taken were a mixture of fresh and worn individuals, but at 7000 ft. there were hardly any fresh *eurytheme* before late July-early August.

In the northeast, the European Cabbage Butterfly, *Pieris rapae* L. (Pieridae), overwinters everywhere. This is probably true in the Sierra as well, but there is evidence that its populations are bolstered by immigrants from lower elevations. Apparent fly-ups of *P. rapae* in worn condition were taken at 5000 ft., v.17, and 7000 ft., v.31. Fresh butterflies of the overwintering phenotype were recorded at 5000 ft. on vii.7 and at 7000 ft., on vi.30, vii.7, and vii.14. The first fresh summer phenotype *rapae* were taken at both elevations on vii.28—just a bit early to be the progeny of a brood eclosing at the beginning of July. The spring brood of *P. rapae* begins flying in the Valley in late February and the second flight begins in late April. The immigrant *rapae* taken in the mountains in May were of the early summer phenotypes prevalent in the Valley at that time.

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